Spatial Data Standards
for facilities, infrastructure, & environment
(SDSFIE)

and

Facility Management Standards
for facilities, infrastructure, & environment
(FMSFIE)

History of Development
and
User Benefits

(Updated for the SDSFIE/FMSFIE Release 2.00, January 2001)

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History of Development and User Benefits

Abstract

Two of the major initiatives assigned to The Computer-Aided Design and Drafting (CADD)/Geographic Information System (GIS) Technology Center for Facilities, Infrastructure, and Environment have been the development of the Spatial Data Standards for Facilities, Infrastructure, and Environment (SDSFIE) and Facility Management Standards for Facilities, Infrastructure, and Environment (FMSFIE). These projects have focused on the development of graphic and nongraphic standards for GIS and Facility Management (FM) implementations at Air Force, Army, Navy, and Marine Corps installations and U.S. Army Corps of Engineers Civil Works activities.

The SDSFIE provide a standardized grouping of geographically referenced (i.e., geospatial) features (i.e., real-world features or objects depicted graphically on a map at their real-world location (i.e., coordinates). Each geospatial feature has an "attached" attribute table containing pertinent data about the geospatial feature. The FMSFIE provide a standardized database format and structure for "business," event, and temporal data (e.g., inspections, repairs) related to SDSFIE geospatial features and/or architectural, engineering, and construction (A/E/C) CADD objects.

The SDSFIE and FMSFIE are the only "nonproprietary" GIS and FM standards designed for use with the predominant commercially available off-the-shelf GIS and CADD (e.g., ESRI ArcInfo and ArcView; Intergraph MGE and GeoMedia; AutoDesk AutoCAD, Map and World; and Bentley MicroStation and GeoGraphics), and relational database software (e.g., Oracle and Microsoft Access). This nonproprietary design, in conjunction with its universal coverage, has propelled the SDSFIE into the standard for GIS implementations throughout the Department of Defense (DoD), as well as the de facto standard for GIS implementations in other Federal, State, and local government organizations; public utilities; and private industry throughout the United States and the World.

The SDSFIE and FMSFIE are distributed via CD-ROM and the Internet (http://tsc.wes.army.mil). A user-friendly interactive Microsoft Windows-based software application installs the SDSFIE/FMSFIE "Browser" and "Generator" applications on desktop computers and networks. The "Browser" application provides viewing and printing capability. The "Generator" application generates Structured Query Language (SQL) code for construction of the GIS database.

The CADD/GIS Technology Center annually updates and expands the SDSFIE and FMSFIE. Prior to July 1999, the SDSFIE was known as the Tri-Service Spatial Data Standards (TSSDS) and the FMSFIE was known as the Tri-Service Facility Management Standards (TSFMS). Release 1.40 of the TSSDS (which was the first release published on CD-ROM) was completed in July 1995. Release 1.60 of the TSSDS was published in November 1996. The TSSDS Releases 1.70 and 1.75 were published in August 1997 and January 1998, respectively. The TSSDS Release 1.80 of the TSSDS, which also included the first release of the TSFMS, was published in February 1999. From July 1999 until January 2001, the acronyms SDS and FMS

were used. The SDS/FMS Releases 1.90 and 1.95 were completed in December 1999 and April 2000, respectively. The SDSFIE/FMSFIE Release 2.00 was completed in January 2001.

CADD/GIS Technology Center

In 1992, the Army, Navy, and Air Force established the Tri-Service CADD/GIS Technology Center at the U.S. Army Engineer Waterways Experiment Station (WES) in Vicksburg, Mississippi. In July 1999, the name of the Center was changed to The CADD/GIS Technology Center for Facilities, Infrastructure, and Environment. The purpose of the name change was to reflect a broader mission beyond the Department of Defense (DoD). The Center's primary mission is to serve as a multi-service vehicle to set computer-aided design and drafting (CADD) and geographic information system (GIS) standards; coordinate CADD/GIS facilities systems within the Department of Defense (DoD); promote CADD/GIS system integration; support centralized CADD/GIS hardware and software acquisition; and provide assistance for the installation, training, operation, and maintenance of CADD and GIS systems.

The intent of the CADD/GIS Technology Center standards development initiatives has been to develop usable CADD, GIS, and facility management (FM) standards that will satisfy the project life-cycle concept for digital data. This concept requires a set of CADD, GIS, and FM standards for initial data collection, analysis, design, construction, and subsequent master planning, facility management, and maintenance. This allows for direct integration from CADD engineering design or as-builts to such GIS analysis tasks as master planning and FM. The project life-cycle concept for CADD/GIS/FM standards development is shown in Figure 1.

GIS Standards Development Effort

In February 1993, the CADD/GIS Technology Center was charged with the development of a set of GIS standards (i.e., the Tri-Service Spatial Data Standards (TSSDS) (now called the Spatial Data Standards for Facilities, Infrastructure, and Environment (SDSFIE)) for base comprehensive planning and FM at DoD installations and Civil Works activities. These functions had been conducted using manual methods for many years. In more recent years, each Service had developed procedures to perform these functions, using a variety of digital systems. With the development of spatial data technology, the development of GIS to perform the base comprehensive planning and FM functions had been conducted independently by each service. These developments had proceeded without DoD coordination and without consideration for standardization. The SDSFIE are intended to correct these problems and provide consistency within the DoD for GIS applications related to facilities planning and management and Civil Works projects.

The Savannah and Fort Worth Districts, U.S. Army Corps of Engineers, had assisted several Army military installations with the development of GIS for a variety of applications in accordance with the Army Master Planning Instructions. Edwards AFB, Eglin AFB, and Patrick AFB also had ongoing GIS projects founded upon the Air Force Base Comprehensive Plan. In addition, the Patuxent River Naval Air Station and Crane Division Naval Surface Warfare Center, and other Navy Installations had developed GIS to meet the requirements outlined in the Navy Master Planning Guidelines. Also, many Corps Districts had developed master plans for numerous Civil Works projects using GIS.

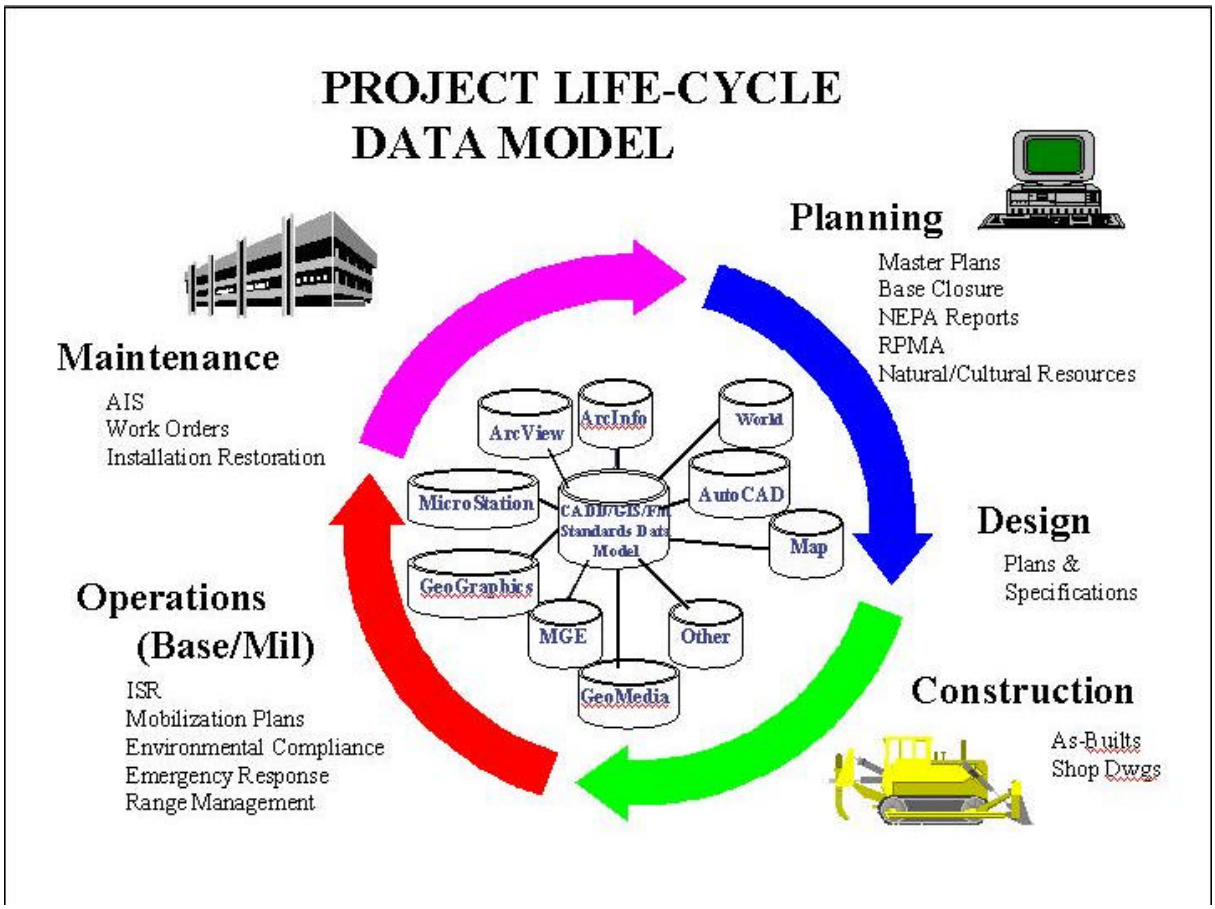

Figure 1. Project Life-Cycle Data Model

The three DoD military services (i.e., Army (including the Army Corps of Engineers (USACE)), Air Force, Navy (including Marine Corps)) each had planning guidelines which recommended the division of data into thematic groups. Each military GIS development used these guidelines and thus was service and site specific. Each Civil Works GIS was project specific. Thematic data types or categories in use at that time are listed in Table 1 for each Service. During the early stages of research and development of the SDSFIE, it became apparent that the use of data in the GIS should be expanded outside the master planning/base comprehensive planning function at military installations and Civil Works projects. This added the need for several more schemas for the division of data based on functional requirements.

Numerous guidelines and existing schema were evaluated by the CADD/GIS Technology Center and none satisfied the generic and extensible requirements needed to define standards for a DoD military installation and Civil Works project. Therefore, the SDSFIE schema was developed by the CADD/GIS Technology Center from a combination of many schemas, using broad data groups as chapter divisions. These chapter divisions are now referred to as *Entity Sets*, and they consist of both graphic and tabular data related to a specific area or discipline. They represent related groupings of *Entities*, the geographical features that are the basis for all GIS- and CADD-based FM systems.

Table 1. Thematic Data Divisions

Air Force	Army	Navy	FGDC*
Natural and Cultural Resources	Engineering Environmental (Conservation)	Land Environment	Base Cartographic
Environmental Quality	Environmental (Compliance, Restoration, Pollution Prevention)	Water Environment	Bathymetric
Layout and Vicinity Maps	Command, Control, Communications, Computers (C^4)	Air Environment	Cadastral
Land Use Plans		Biologic System	Cultural and Demographics
Airfield Operation		Cultural System	Geodetic
Air Installation Compatible Use Zone		Socio-Economic System	Geologic
Utilities Systems		Existing Built System	Ground Transportation
Communication and Navigation		Regulatory System	International Boundaries
Transportation Systems			Soils
Energy Plan			Vegetation
Architectural Compatibility			Wetlands
Landscape Development			
Future Development Plan			
Fire Protection			
Contingency Planning			

*Federal Geographic Data Committee

The intent of the SDSFIE development effort has been to develop a nonproprietary data and format content standard which will support different CADD, GIS, and FM software applications. The assignment of specific entities to entity sets is a function of data maintenance. In this way, it is possible to more easily reduce the redundancy of information within the standard. This schema met the data sharing requirements of the National Spatial Data Infrastructure (NSDI).

The data dictionary (standard schema) part of the SDSFIE effort had been evolving at Army, Navy, and Air Force specific installations and Civil Works organizations over several years. The CADD/GIS Technology Center has built upon the prior efforts and incorporated other functional area specific schema to create a more robust standard for DoD facilities and Civil Works projects. Numerous existing databases, such as the Army's Integrated Facilities System Mini/Micro (IFSM), the Corps' Cultural Resource Information System (CRIS), the Navy's Resources Automated Management System (RAMS), the Activity Planning and Management Model (APMM), the Air Force Environmental Restoration Program Information Management System (ERPIMS), the USACE Mississippi Valley Division Regional Engineering and Environmental GIS (REEGIS), and numerous others have been reviewed and used in the development of the SDSFIE.

In addition, the CADD/GIS Technology Center has worked closely with other DoD and Federal standardization authorities (e.g., the Federal Geographic Data Committee (FGDC), Defense Information Systems Agency (DISA), Defense Environmental Security Corporate Information Management (DESCIM), National Imagery and Mapping Agency (NIMA), and Environmental Protection Agency (EPA)) in the development of GIS and FM data standards. The FGDC Metadata Standard was incorporated into the TSSDS Release 1.4, and the FGDC Wetlands, Soils, and Vegetation data standards were incorporated into the TSSDS/Tri-Service Facility Management Standards (TSFMS) Release 1.80. The Center began

incorporating (and linking to) approved data elements from the DISA Defense Data Dictionary System (DDDS) with the TSSDS/TSFMS Release 1.80.

National and industry data standards (e.g., those developed by the International Standards Organization (ISO) and the American Society for Testing and Materials (ASTM)) have also been incorporated into the SDSFIE and FMSFIE. For example, the ISO standards for units of measure were incorporated into the TSSDS/TSFMS Release 1.80. The ASTM standards for soil physical classifications were incorporated into the TSSDS Release 1.4.

Traditionally, either Intergraph Modular GIS Environment (MGE) or ESRI ArcInfo has been the predominant GIS software packages in use at DoD installations and Civil Works activities. The majority of CADD-based FM software applic ations use either Bentley MicroStation or AutoDesk AutoCAD. The SDSFIE physical data model was designed to work with these commercially available GIS and CADD software packages without requiring software customization or the development of specialized software applications.

Until recently, with the development and proliferation of the Microsoft Windows NT operating system and the advancement in personal computer (PC) capabilities, most GIS software operated on UNIX-based workstations. Today, the GIS market is growing and changing at a rapid pace due largely to the introduction of robust GIS functionality on personal and desktop computers. Also, the gap between the capabilities and operational characteristics of traditional CADD and GIS software is rapidly narrowing. Today, the majority of SDSFIE GIS implementations use Windows NT-based GIS software packages (e.g., ESRI ArcView, Intergraph GeoMedia, AutoDesk Map, ESRI ArcInfo, Intergraph MGE, and Bentley GeoGraphics).

The CADD/GIS Technology Center stays abreast of new developments in CADD, GIS, and computer technology. Since its conception in 1993, the structure of the SDSFIE has evolved to keep pace with the rapidly expanding capabilities of GIS software. The TSSDS Release 1.20 (published as a draft report in November 1993) reflected a "traditional" GIS structure with a "flat-file" database management system (DBMS). dBase (Borland, Inc.) and Microsoft Excel are examples of a "flat-file" DBMS.

Beginning with Release 1.40 (published in July 1995, the SDSFIE (formerly called TSSDS) has been transitioning to a GIS-compatible relational database management system (RDBMS) structure. An RDBMS is a computer program that provides a means of managing the related data contained in one or more database tables. The computer language that has been developed for organizing, managing, interacting, and retrieving the data stored in an RDBMS is called Structured Query Language (SQL). The American National Standards Institute (ANSI) and the ISO published standards for SQL in 1986. The ANSI/ISO SQL standards were significantly expanded in 1992. SQL is also included in the U.S. Federal Information Processing Standards (FIPS). Oracle (Oracle Corporation) and Informix (Informix Software Inc.) have traditionally been the most widely used RDBMS. The growing popularity of Windows NT (Microsoft) has resulted in the growth in popularity of RDBMS's complying with Microsoft's Open Database Connectivity (ODBC) standard, such as Access (Microsoft). Other popular RDBMS's include Foxpro (Microsoft), Paradox (Borland), and SQL Server (Microsoft).

Release 1.40 (published in July 1995) provided the first interactive Microsoft Windows-based SDSFIE application published on CD-ROM. The Windows 3.1, 16 bit application was developed and distributed using Microsoft Access "Run-Time" software. Release 1.40 contained basically a Master Planning/Base Comprehensive Planning level of detail. Changes in the standards were also based on over 350 comments received from field reviewers of the draft TSSDS, Release 1.20.

Release 1.60 (published on CD-ROM in November 1996) extended beyond the planning level of detail in many areas. Extensive content additions were made to the Standard's Improvements, Landform, Transportation, Utilities, Flora/Fauna, Climate, and Environmental Hazards Entity Sets. A total of 1,595 new entities (features to be depicted on a map or drawing) were incorporated into Release 1.60. Additional enhancements included: (a) electronic tools providing help with the conversion from Release 1.40; (b) development of help screens; (c) upgrade of the SQL generation capability (with Microsoft Access added as one of the options); (d) capability for installation on a network accessible to many users (Release 1.40 could only be installed on the C drive of each user's computer); (e) establishment of an e-mail address for TSSDS users to submit comments, requests for future additions/enhancements, and TSSDS user registrations to the Center; and (f) establishment of a TSSDS list-server for electronic discussions/communications among all TSSDS discussion group members.

Release 1.70 (published on CD-ROM in August 1997) focused on the provision of user friendly updates and modifications to the TSSDS application. Release 1.70 introduced the concept of a "Feature Browser," provided a few changes to the data standards content, and improved the SQL generation capability.

Release 1.75 (published on CD-ROM in January 1998) provided the first Windows 95/NT, 32-bit Browser application, developed using Microsoft Visual Basic.

Release 1.80 (published on CD-ROM in February 1999) marked a major milestone in the CADD/GIS Technology Center's development of SDSFIE for GIS implementations. Among the most significant accomplishments were (a) the first standard for GIS implementations of the FGDC's Wetlands, Vegetation, and Soils Standards; (b) inclusion of the USACE Mississippi Valley Division's REEGIS; (c) development of "Filters" (predefined subsets of the standards) for REEGIS, Civil Works, Range and Training, Small Scale Mapping, Environmental Restoration, and Environmental Compliance; and (d) development of two interactive 32-bit Windows (NT, 95, and 98) software applications (i.e., the Browser and Generator). Approximately 4,500 CD-ROMs containing the TSSDS/TSFMS Release 1.80 (now called SDSFIE/FMSFIE) were published and distributed throughout the world.

Major enhancements provided with Release 1.90 (published on CD-ROM in December 1999) included: (1) the development of a new "Filter Maker" software application which permitted GIS Users to develop their own custom subsets of the SDSFIE/FMSFIE, (2) updates to the SDSFIE Symbol Sets and Symbology, (3) the development of one new Entity Set entitled "Future Projects", (4) the incorporation of new environmental sampling/analysis related tables and domain values from the Air Force Environmental Restoration Program Information Management System (ERPIMS), and (5) the incorporation of new features related to Military Range & Training and Army Corps of Engineers Civil Works activities. Approximately 1,500 CD-ROMS containing the SDS/FMS Release 1.90 were published and distributed.

Release 1.90 also marked the discontinuance of the Windows 3.1 based 16 bit application.

Release 1.95 (published on CD-ROM in April 2000) provided the development of a new "Generator" application specifically for Intergraph GeoMedia. Release 1.95 was an "interim release of the SDS/FMS with 500 CD-ROMS being published and distributed in May at the CADD/GIS Technology Symposium and Exposition 2000 held at St. Louis, Missouri.

Release 2.00 (completed in January 2001) provided dramatic enhancements to collection of SDSFIE/FMSFIE software applications (i.e., Toolbox) with: (1) significant enhancements to the "Browser", "Filter Maker", and "SQL Generator" (formerly called "Generator") applications, (2) the development of "Filter Eraser" (permits the deletion of User defined custom filters), "Access Builder" (permits the construction of SDSFIE/FMSFIE compliant Microsoft Access 97 database tables), and "Data Creator" (provides a data entry form for use with a Microsoft Access 97 database). Release 2.00 also provided a substantial expansion of standards content with 11 new Entity Classes, 57 new Entity Types, 73 new Attribute Tables, 269 new Attributes, 71 new Domain Tables, and 216 new Domain values. Most notable additions/changes were: (1) The incorporation of a new data type "M" for long, unstructured text fields (memo fields); (2) An increase in the field lengths for 20 "Common_General" Entity Class table Primary Keys which permits Users to use more descriptive or recognizable names as a Primary Key for such fields as "owner_id", "project_id", etc.; (3) A total revision of the Communications Entity Sets; (4) integration with the U.S. Army Corps of Engineers Survey Engineering and Monumentation Management System (SEEMS); (5) The development of a new Entity Class entitled "Buildings_Space" to address building space management considerations; (6) The incorporation of additional real estate related features (Entity Types, tables, and attributes from the USACE REMIS database; (7) The incorporation of additional airfield related features (Entity Types), tables, attributes, and domain values from NIMA & DISA data models/standards; and (8) The incorporation of additional environmental compliance and utility related features (Entity Types, tables, attributes, and domain values). Several SDSFIE/FMSFIE Users (e.g., Cherry Point Marine Base, Patuxent River Naval Air Station, USACE Mississippi Valley Division & Districts, and numerous GIS development contractors) submitted comments which were incorporated into Release 2.00.

FM Standards Development

The first release of the Facility Management Standards (FMSFIE) (formerly called Tri-Service Facility Management Standards (TSFMS)) was published with Release 1.80 of the SDSFIE (formerly called Tri-Service Spatial Data Standards (TSSDS)) (published on CD-ROM in February 1999). The first release of the FMSFIE focused on environmental compliance and restoration.

The FMSFIE are being developed to provide:

- "Business" FM, "event," and temporal information (e.g., construction, operation, maintenance, repair, and inspection records) concerning the real-world features/objects depicted in the SDSFIE and architectural, engineering, and construction (A/E/C)/CADD Standards.

- Capability to link to and share data with "corporate" databases, computerized information management systems, and commercially available FM software.

In developing the FMSFIE, the CADD/GIS Technology Center did not want to develop a separate "stand-along" standard (i.e., a standard which contained graphic CADD and GIS standards different from those already depicted in the SDSFIE and A/E/C CADD Standards). The CADD/GIS Center's goals in development of the SDSFIE and A/E/C CADD Standards have been well defined, as described below:

- The A/E/C CADD Standards provide a CADD standard for the drawings prepared for design/construction projects. The emphases are on: (1) A graphic standard (i.e, colors, line types, fonts, and symbols) and (2) CADD level/layer assignments. The CADD drawings typically have a project specific "origin" (e.g., the origin of a building site plan may be based upon a temporary benchmark (TBM) established for the design and construction of that particular project) which is not geographically referenced (i.e., not geospatial, or directly related to a geographic coordinate system). For example, the A/E/C CADD standards would be used to prepare the necessary drawings for the construction of a building, it's parking area, and interior and exterior utilities.

- The SDSFIE provide a standard for the development of a GIS or CADD drawings where all features (i.e., "real-world" objects) are geographically referenced. The emphases are on: (1) The geospatial referencing of each feature and (2) The collection and maintenance of accurate data concerning each feature, which is stored in database tables. For example, the SDSFIE would be used to: (1) Depict the graphic locations (using GIS or CADD software) of all buildings, parking areas, and exterior utilities at a military installation or civil works project, and (2) generate a database schema for geospatial feature attribute data.

The goal of the CADD/GIS Center is to provide a seamless graphic and nongraphic "life-cycle" CADD/GIS/FM project data model (see above Figure). For example, the ultimate goal is to permit the CADD drawings developed during the design and construction phase to be readily available for use in a GIS and for facility management, and vise versa. In a broad sense, the term "facility management" comprises the entire "life-cycle" project data model, thereby encompassing all three of the CADD/GIS Center's CADD/GIS/FM standard development efforts. In other words, to perform "facility management" activities, an organization will require use of: (1) GIS or CADD (as defined in the SDSFIE), (2) CADD (as defined by the A/E/C CADD standards), and (3) "business", event, and temporal data as defined by the FMSFIE.

Several different strategies and options were evaluated by the CADD/GIS Technology Center during 1997 and 1998 for integration of the FMSFIE with the CADD/GIS Technology Center's CADD and GIS standards development efforts (i.e., the SDSFIE and A/E/C CADD Standards). In early 1998, the following two options were presented to the CADD/GIS Technology Center's advisory groups (i.e., the FMSFIE Task Group and Field User Groups (FUGs)), and CADD/GIS Technology Center's Oversight Groups (i.e., Executive Working Group (EWG) and Field Technical Advisory Group (FTAG)):

- Option 1: Incorporate the FMSFIE within the current SDSFIE Data Model. This option would involve the development and incorporation of FM Entity Classes within the appropriate existing SDSFIE Entity Sets.

- Option 2: Develop the FMSFIE as a separate standard. This option would involve the development of separate FM Entity Sets built around a data model structure similar to existing SDSFIE Data Model.

Option 1 was chosen and implemented, beginning with the TSSDS/TSFMS Release 1.80. Additional FMSFIE components (i.e., Entity Classes, Tables & Attributes) have been incorporated into each subsequent consolidated release (SDS/FMS Releases 1.90 & 1.95, and SDSFIE/FMSFIE Release 2.00).

In March 1999, the FMSFIE Task Group consisting of representatives of the Facility Management Field User Group and other FM experts within the DoD developed the following definition and scope for the FMSFIE:

> *The scope of Facility Management Standard is the data describing the control and reporting of real property and derived entities that must be considered in its use.*

In Fiscal Year 2000, a new FMSFIE Strategic Plan was prepared and approved by the CADD/GIS Technology Center's Standards Working Group (SWG) and Corporate Staff (CS). The Strategic Plan provided a framework and strategy for evolution of the FMSFIE to a "transactional" (i.e., Option 2 concept discussed above) data model closely integrated with the SDSFIE & A/E/C CADD Standards. Development of the "transactional" FMSFIE data model and standards began in Fiscal Year 2001.

Contributors and Coordination

The SDSFIE and FMSFIE have been developed based on input from various technical experts; through the review and analysis of existing working DoD and State government GIS's; through the review and analysis of various existing database management systems used throughout DoD and the Federal government; and content contributions from Federal, State, local, and private sector sources. The CADD/GIS Technology Center has organized FUGs whose membership is composed of subject matter, CAD, and GIS technical experts to assist in the development of the GIS and FM standards and other CADD/GIS projects.

Benefits of GIS and FM Standards

The collection, storage, management, and analysis of geospatial and FM data are critical components of everyday business activities. Geospatial data can be stored in a number of ways (i.e., paper, microfilm, and/or electronically) that may not be readily accessible and usable, or easily shared with, or reported to others. CADD and GIS software can provide cost-effective and efficient tools to apply and manage such data. However, careful planning and the use of consistent data storage and implementation standards are necessary to achieve the full potential offered by CADD and GIS technology.

DoD and other organizations require that geospatial and FM data be delivered in a digital format. Digital data products are especially useful for life-cycle management of an organization, from planning through facilities management to disposal. To further improve the use of digital data and to have the capability to share databases among organizations, graphic and nongraphic standards must be mandated. Standards are necessary to ensure that:

a. The geospatial and data gathered and created in one life-cycle management phase (e.g., planning) are readily usable in the subsequent phases (e.g., FM or disposal).

b. The digital maps and data are applicable for their intended use.

c. The digital maps and data are compatible with the CADD and GIS equipment and software used by an organization.

d. The digital maps and data created for one project, or project discipline, are compatible with those created for other similar projects.

e. The digital maps and data can be transferred and integrated with other applications, such as CADD, cost estimating, specification development, FM, and environmental management and compliance.

f. The digital maps and data generated at one organization will comply with the same graphic and nongraphic standards as those developed by another organization.

g. The compatibility of the data with pertinent national, international, and industry standards is maintained.

An organization's rights to ownership of the digital data and other deliverables developed by a contractor must be clearly defined in the technical contract provisions. The organization has a legal right to demand unrestricted ownership to all data, designs, and materials for which the organization has paid 100 percent of the development cost. If the contractor has to develop data, designs, or materials above and beyond what the organization specifies and pays for 100 percent, then the contractor owns the rights to that percentage.

The SDSFIE and FMSFIE are "nonproprietary" and are available for use as a GIS and FM standard by any organization. Technical contract provisions requiring the

delivery of SDSFIE and FMSFIE compliant digital data will: (a) Protect an organization's investment and ensure 100 percent ownership of the digital data, and (b) Save the organization the considerable expense of developing their own SDSFIE and FMSFIE data standard. In addition, the SDSFIE and FMSFIE provide a stable, nonproprietary database structure that protects the organization's data investment in a rapidly changing CADD, GIS, and FM software environment.

In summary, the findings of a Fiscal Year 1998 benefit-to-cost study produced the following conclusions for the SDSFIE and FMSFIE:

a. *Financial.*

(1) The SDSFIE and FMSFIE provide substantial savings to users in developing GIS and FM systems.

(2) The SDSFIE and FMSFIE provide substantial savings to users by providing the ability to share data with other organizations.

b. *Customer.* The SDSFIE and FMSFIE provide a faster delivery of the GIS and FM product at less cost.

c. *Internal business process.*

(1) The SDSFIE and FMSFIE facilitate the sharing of information within organizations.

(2) The SDSFIE and FMSFIE permit easier translation of information.

(3) The SDSFIE and FMSFIE enhance interoperability between CADD, GIS, FM, and RDBMS software platforms.

d. *Learning and Growth.* The SDSFIE and FMSFIE encourage teaming within and across organizations.